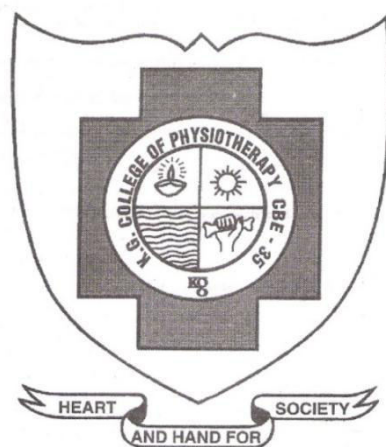


“EFFECTS OF PILATES, CALLISTHENICS AND PLYOMETRIC TRAINING ON PHYSICAL PERFORMANCE OF VOLLEYBALL PLAYERS”

-A COMPARATIVE STUDY



REGISTER NO:271750142

ELECTIVE: PHYSIOTHERAPY IN SPORTS

A DISSERTATION SUBMITTED TO THE TAMILNADU

Dr. M.G.R MEDICAL UNIVERSITY, CHENNAI,

AS PARTIAL FULFILLMENT OF THE

MASTER OF PHYSIOTHERAPY DEGREE

MAY 2019

CERTIFICATE

Certified that this is the bonafide work of **Mr. RAJU SUDARSON** of K.G. College of Physiotherapy, Coimbatore submitted in partial fulfilment of the requirements for the Master of Physiotherapy Degree course from the Tamil Nadu Dr. M.G.R. Medical University under the **Registration No:271750142** for the MAY 2019 Examination.

Place:

Date:

Principal

A Dissertation on

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I INTRODUCTION

Volleyball is a multi directional sport where the players need to move quickly and swiftly on volleyball court. Since the game is point-oriented, the player hits the ball in a fast pace between each other for gaining a point, the team who lets the ball down offers a point to opponent.

Volleyball is a sport with increasing recognition worldwide which has considerable effects on athletes physical fitness. Coaches and physical educators employ advanced exercises in order to improve and enhance physical and technical skills in their trainees (El-Sayed et al, 2010). A key objective is to enable volleyball players for better offense and defense at every spot in the court and at every moment during the game. The repeated movement of jumps, stops, and volleyball techniques exert a great pressure on joints and increase the risk of injuries. Protection against the risks is often created by strengthening the musculature surrounding joints and by enhancing joint flexibility (Schirm et al, 2011).

The widespread of volleyball all over the world has the greatest effect in promoting the level of players considerably in all sides of preparation especially the physical one. It was necessary to use advanced techniques enabling players to reach highest level technically or physically besides coaches getting ample information about their players through the

continuation of developing the level and its follow-up.(Hassenen et al,1986).

Volleyball skills aren't easy enough and need very long time for perfection. They need training based on special scientific basis especially, we take into account the speed of the ball, the smallest area of the court and the necessity that every player should defend and attack at any time on changing the position with every point he scores.(Shokry et al,1996).

The ability to jump, move swiftly inside the court and hit the ball at good pace all plays an effective and more important role in volleyball. The above skills needs greater amount of physical fitness components such as agility, power, endurance, flexibility, speed and coordination. These skills are greatly complicated that it is nearly the outcome of vertical force and horizontal speed besides harmony and synchronization of the work of arms and feet (swings and pushing)(Keyur Patel et al 2014).

It is much necessary to perfect a jump (which is a skill in its self) should develop with the use of Fartleks, Plyometrics, Pilates and others by nonstop continuous training that's because it is one of the most important necessities and requirements of the game(Jyoti Chauhan et al,2014).

Pilates technique is considered as one of the modern training techniques in general sports activities, it also plays a important role in volleyball training. Pilates is a set of exercises defined to build muscular power, flexibility, muscular endurance and achieving the whole body balance through motor performance with suitable breathing to re improve the relation between mind and body. Pilates is not just exercise or a random choice of particular movements, it is a system of physical and mental conditioning that can enhance ones physical strength, flexibility and co-ordination as well as reduce stress, improve mental focus, and foster an improved sense of well-being.(Rajeev srivastava et al,2016).

Pilates training also strengthens the deep core muscles and improves movement, efficiency and muscle control. As we all know volleyball needs a humongous amount of power, agility, speed, endurance and flexibility in its long course of game. In order to perform all these above mentioned fitness components, the player should have a enormous strength in his deep core group muscles which can be easily obtained from pilates training(Rajeev srivastava et al,2016).

Plyometrics, also known as “jump training” or “plyos”, are exercises based around having muscles exert maximum force in at a time as possible, with the goal of increasing both speed and power. This training focuses on learning to move from a muscle extension to a contraction in a

rapid or “explosive” way, for example with specialized repeated jumping. Plyometrics are primarily used by athletes to improve performance, and are used in the fitness field to a much lesser degree.(sandipkumar pareh,2014).

Plyometrics exercises such as jumping, hopping, skipping, and bounding are executed with the goal of increasing dynamic muscular performance.volley ball players do movements like jumping, hoping, lunging actions repeatedly. A 6 weeks of plyometric training has increased the root mean square EMG of vastus medialis, lateralis and hamstring muscles during countermovement jump (CMJ). Therefore, Plyometrics can be used for increasing dynamic athletic performance such as vertical jump ability, speed, agility , and muscle activation of lower extremities(Kerim Sözbir et al.,2016).

Callisthenics are aerobic and dynamic exercises and are suitable for sedentary and also for older people. They are rhythmic, smooth, enjoyable exercises that are easy to perform alone or in a group format, and can be modified according to subject’s fitness levels. Callisthenics consist of a variety of simple movements that are intended to increase body strength and flexibility using the weight of one’s own body as resistance.(Rajeev srivastava et al,2016).

Callisthenics training helps in developing both muscle endurance and cardiovascular fitness, in addition it also helps in improving psycho-motor skills such as balance, agility and coordination, so it can be beneficial for improving both muscular and cardiovascular fitness in volleyball players.

1.1 NEED FOR STUDY:

In volleyball due to sudden change of direction inside the volleyball court, these players need greater amounts of sporting fitness components like speed, agility, power and flexibility.

There were many studies done on finding the effectiveness of pilates, plyometrics and callisthenics in improving performance and injury prevention separately or by comparing any two of the above.

But most of the studies were done by comparing either the two components and with the minimal outcome measure. Therefore this study focuses on improving the performance of a volleyball players by comparing the effects of Pilates, Callisthenics and Plyometrics on the sporting fitness components mentioned above.

1.2 AIM OF THE STUDY:

An experimental study to compare the effects of Pilates, Callisthenics and Plyometric training on physical performance of volleyball players.

1.3 OBJECTIVE OF THE STUDY:

- To study the effects of Pilates training in improvement of physical performance in volleyball players.
- To study the effects of Callisthenics training in improvement of physical performance in volleyball players.
- To study the effects of Plyometric training in improvement of physical performance in volleyball players.
- To compare the effects of Pilates, Callisthenics and Plyometrics in improving physical performance of volleyball players.

1.4 HYPOTHESIS:

NULL HYPOTHESIS:

There is no significant difference in the effect of Pilates, Callisthenics and Plyometrics training in improvement of physical performance of volleyball players.

ALTERNATE HYPOTHESIS:

There is a significant difference in the effect of Pilates, Callisthenics and Plyometrics training in improvement of physical performance of volleyball players.

II REVIEW OF LITERATURE

Sandipkumar Parekh et al,2014.

Plyometric training was more effective than regular practice of volley ball in improving strength balance, jumping power, and sports specific skills of volley ball players

Kerim Sozbir et al,2016.

When the muscles are stretched during an eccentric contraction, they store elastic energy, and this energy, accompanied by a rapid concentric contraction, produces more power than an independent concentric contraction. Plyometric exercise involves stretching the muscles immediately before making rapid concentric contractions . This combined action is commonly called a stretch-shortening cycle and depends on using passively elastic energy in the muscle and the active role of stretch reflex.

Artur Struzi et al,2016.

The effects of plyometric training, also referred to as ballistic training or stretch-shortening exercise, have been studied rather extensively in both athletic and nonathletic populations. Benefits from this type of training include improved measures of muscular strength and power, joint function and stability, reduced incidence of serious knee injuries, and

running economy. That have employed jump-specific plyometric exercises (i.e., depth jumps or drop jumps) have reported significant improvements in vertical jump.

Dimas Sondang Irawan et al,2017.

Plyometric movements are components that can help in improving agility because it exploits the adaptation of stretch-shortening cycles through the neuromuscular system in helping to increase leg muscle power so agility improvement can be achieved.

Kerim Sozbir et al,2016.

Regarding neuromuscular adaptation to Plyometrics, the results generally show positive increases in lower extremity strength, power and Short Stretch Cycle muscle function in healthy individuals.

Vaczi, et al,2011.

Plyometric exercise has been used in all areas of the sport to increase muscle strength and explosive power. Plyometric exercises consist of eccentric movements which are then followed by concentric contractions in the same muscle group. Muscle strength training can contribute to increased acceleration, strength and limb power.

Meylan & Malatesta et al,2009.

In plyometrics the muscle function is drawn before concentric contraction is maximized, followed by rapid movement from the eccentric phase to the concentric which helps stimulate the proprioceptors to facilitate increased muscle recruitment in a minimal amount of time.

Jyoti Chauhan et al,2014.

Pilates exercises led to improvement of nervous system in functioning muscles by improving motor performance. By this it improved agility T test, vertical jump test, the block jump and attack jump in well trained volley ball players.

El-Sayed et al,2010.

The effects of Pilates exercises on leg strength and jumps in addition to offense and defense activities in volleyball players. They found that their Pilates exercises had a significantly positive effect on these parameters as evidenced by an enhanced offense skill of 10.06% and an enhanced defense skill of 20.94%.

June a kloubec et al,2010.

Pilates exercise for 12 weeks, for two 60-minute sessions per week, was enough to stimulate statistically significant increases in abdominal

endurance, hamstring flexibility, and upper-body muscular endurance in middle aged men.

Mahnaz Manshouri et al,2014.

The specially designed Pilates protocol also helped the subjects gain improved volleyball serve skill at the end of the six-week study period, indicating improvements gained in the performance of the muscles engaged in performing the volleyball serve skill. Relevant and carefully designed Pilates exercises may, therefore, be recommended for both beginner players and improving volleyball techniques in professional players.

Segal et al,2004.

The sit-and-reach box test was used by who showed that flexibility was improved in their subjects(female volleyball players) after 5 weeks of administering Pilates exercises which consists of exercises to the core, back, lower extremities.

Emerya et al, 2010.

Joseph Pilates designed an exercise protocol which was meant to enhance muscular strength, flexibility, posture, core stability, structural alignment and endurance while it also improved bodily concentration and balance. Pilates training program was effective in improving abdominal

strength and upper spine posture as well as in stabilizing core posture as shoulder flexion movements were performed.

Gonul babayigit irez et al, 2009.

Conducted study about Pilates exercise positively affects balance, reaction time, muscle strength, number of falls and psychological parameters in 65+ years old women. It concludes that Pilates exercises improve the dynamic balance, flexibility, reaction time and decreases the anxiety.

Rajeev Srivastav et al,2016.

Callisthenics exercises do indeed bring both natural human beauty and strength to us, even at only a moderate level of intensity. Callisthenics greatly enhance our physical fitness and stamina, and markedly increase our personal vitality and overall preparedness for life.

JuneA. Kloubec et al,2010

Callisthenics as a way to improve strength, body composition, and flexibility has been limited; however, studies have shown improvements in muscular endurance and strength. These studies also imply that callisthenic exercises alone may not provide participants with the “most bang for their exercise buck”.

Sureeporn Phrompaet et al,2010.

Flexibility is a crucial element of fitness to gain optimal musculoskeletal function enhancing peak performance. Callisthenics improves overall stamina, strength, energy, agility, coordination, balance, and promotes overall fitness for your health.

Aatit Paungmali et al,2010.

Segmental stability and mobility control of the core body (i.e., lumbo-pelvic control) as well as flexibility of the body parts accentuate peak performance and prevent musculoskeletal injury. These also play a major role in improving the game as well.

Gortsila E et al,2013.

Agility is recognized as the ability to maintain and control body's position while rapidly moving and changing directions as a response to a stimulus . It seems to be related to athletic abilities like strength, power, speed and balance and it's a determinant of sport performance in field and court sports like volleyball, soccer and rugby.

Michal Lehnert et al,2009.

A volleyball player's use of explosive power in vertical, horizontal and side movements is critical. The relationship between explosive power

and the technical and tactical level of the player is especially evident when observing the player's activities at the net, attack from the field and spike serve.

Sheppard JM et al,2014.

Volleyball players need to develop effective power and speed combined with the ability to repeat these efforts, with many efforts for the length of a match. The players need enormous amount of both power and endurance for spiking and blocking repeatedly for longer duration.

Trevor M. Johnson et al,2010.

In volleyball, the few seconds or milliseconds of time taken to move to a ball may be the factor that determines winning and losing, because the volleyball court is small in area, there is no time to reach maximal running speed; therefore, quickness needs to be maximized.

Lee E. Brown et al,2010.

Volleyball players often start from an athletic position with their feet shoulder width apart and their knees bent with weight on the balls of their feet. From this position, they move forward to reach the ball or sprint.

III METHODOLOGY

3.1 STUDY DESIGN:

Pre test – Post test Experimental study design.

3.2 STUDY SETTING:

The study was conducted in K.G Campus, saravanampatti, Coimbatore.

3.3 STUDY DURATION:

The study was conducted over a period of six months.

FREQUENCY: once a day, 30 minutes per session.

DURATION : six weeks.

3.4 STUDY SAMPLING:

The sample size was determined based on a pilot study 15 participants were divided randomly into three equal parts, and the main part of the study was conducted on them. The mean and SD for the parameters for this pilot study with $\alpha = 0.05$ and 90% power were used to calculate the sample size of $N = 45$.

(N= 45),(n=15 each group). All 45 subjects who satisfied inclusion and exclusion criteria were selected and assigned into three groups by using random sampling method as 15 under each group.

3.5 CRITERIA FOR SELECTION OF SUBJECTS

INCLUSION CRITERIA:

- Healthy active collegiate volleyball Players who have been participating in game for atleast 1 year.
- Only male players
- Age group 18-25 years
- BMI of 18-24 was included

EXCLUSION CRITERIA:

- Any injury within 1 months
- Psychologically unstable
- Female players not included
- Subjects with neurological problems
- Subjects with musculoskeletal and neurological abnormalities
- Players not willing to participate

3.6 VARIABLES

INDEPENDENT VARIABLES

- Flying 30m sprint test.
- Illinois agility test.
- Sit and reach test.
- Vertical jump test.

DEPENDENT VARIABLES

- Speed.
- Agility.
- Flexibility.
- Power.

3.7 ORIENTATION OF THE SUBJECTS

All participants who are included in the study were clearly explained about the procedure, their rights and contradiction of study conducted and asked to fill and sign the consent form. They were also asked to inform if they feel any discomfort.

3.8 PROCEDURE

A total of 45 active collegiate volleyball players were taken and randomly divided into three groups, each group consists of 15 players.

45 players in three groups had underwent a baseline assessment of the taken fitness components such as sprint, agility, power and fitness by using the tests as mentioned above.

PROCEDURE FOR BASELINE ASSESSMENT TESTS TAKEN FOR SPORTS FITNESS COMPONENTS:

FLYING 30m SPRINT:

OBJECTIVE

To monitor the development of the athlete's maximum sprint speed.

APPARATUS REQUIRED

To undertake this test, you will require:

- Flat non-slip surface,
- Cones,
- Stopwatch.

PROCEDURE:

This test requires the athlete to sprint 60 metres.

- The athlete conducts a warm-up for 10 minutes
- The assistant marks out a 60-metre straight section (A-C) with cones and places a cone at the 30-metre point (B)
- From a sprint start with appropriate start commands (on your marks, set, "GO") from the assistant the athlete sprints the 60m
- The assistant starts the stopwatch on the command "GO"
- The assistant records the time the athlete's torso crosses the 30-metre point (B) and the 60-metre point

ILLINOIS AGILITY TEST

OBJECTIVE:

The objective of this study is to monitor the athletes development in Agility.

APPARATUS REQUIRED:

- flat non-slip surface,
- cones,
- stopwatch,
- measuring tape.

PROCEDURE:

The length of the course is 10 meters and the width (distance between the start and finish points) is 5 meters. 4 cones are used to mark the start, finish and the two turning points. Another four cones are placed down the center an equal distance apart. Each cone in the center is spaced 3.3 meters apart. On the 'Go' command the stopwatch is started, and the athlete gets up as quickly as possible and runs around the course in the direction indicated, without knocking the cones over, to the finish line, at which the timing is stopped. The faster of two trials is used for scoring.

VERTICAL JUMP TEST

The Sargent Jump Test (Sargent,1921), also known as the vertical jump test, was developed by (Dr. Dudley Allen Sargent,1849-1924).

OBJECTIVE

To monitor the development of the athlete's power in lower extremity.

APPARATUS REQUIRED

- Wall,
- Tape measure,

- Chalk,
- Assistant.

PROCEDURE

- The athlete warms up for 10 minutes
- The athlete chucks the end of his/her fingertips
- The athlete stands side onto the wall, keeping both feet remaining on the ground, reaches up as high as possible with one hand and marks the wall with the tips of the fingers (M1)
- The athlete from a static position jumps as high as possible and marks the wall with the chalk on his fingers (M2)
- Then measure and record the distance between M1 and M2
- The athlete repeats the test 3 times
- Then calculate the average of the recorded distances and use it

SIT & REACH TEST

OBJECTIVE

The objective of this test is to monitor the development of the athlete's lower back and hamstring flexibility.

APPARATUS REQUIRED

To undertake this test, you will require:

- Box,
- Metre Ruler,
- Tape.

PROCEDURE:

The Sit and Reach Test was conducted as follows:

- The athlete warms up for 10 minutes and then removes their shoes
- The assistant secures the ruler to the box top with the tape so that the front edge of the box lines up with the 15cm (6 inches) mark on the ruler and the zero end of the ruler points towards the athlete
- The athlete sits on the floor with their legs fully extended with the bottom of their bare feet against the box
- The athlete places one hand on top of the other, slowly bends forward and reaches along the top of the ruler as far as possible holding the stretch for two seconds
- Then record the distance reached by the athlete's fingertips (cm)
- The athlete performs the test three times

- Then calculate and record the average of the three distances and uses this value to assess the athlete's performance.

PROCEDURE FOR THE TRAINING GIVEN TO THE GROUPS:

GROUP-A

This group was trained with regular volleyball training which consists of warm-up and exercises session added with pilates training for 30 minutes which is done straight after the warm-up sessions.

PILATES TRAINING FOR 6 WEEKS

EXERCISES FOR I & II WEEK-

NO	EXERCISE	TARGET MUSCLES	REPETITION
1	PELVIC CURL	Abdominals, Hamstrings & Quadriceps Femoris ,Gluteus Maximums.	05
2	CHEST LIFT	Rectus Abdominus, Internal & External Oblique Muscles	10
3	LEG LIFT SUPINE	Quadriceps Femoris, Internal & External Oblique Muscles	10

4	LEG LIFT SIDE	Quadriceps Femoris, Posterior Spinal Group, Internal & External Oblique Muscle	10
5	LEG PULL SIDE	Adductor Longus, Brevis, Magnus Gracilis, Pectineus Muscles	10
6	SPINE TWIST SUPINE	Abdominals, Quadriceps & Hamstring group of Muscles	10
7	CHEST LIFT WITH ROTATION	Internal & External Oblique, Rectus & Transverses Abdominus Muscles	5 each side
8	BACK EXTENSION	Abdominal group, Gluteus Maximus & Hamstrings Muscle	5 each side

Rest between exercises:20 seconds.

Rest between set of exercises:45-60 seconds.

EXERCISES FOR III & IV WEEK

NO	EXERSISE	TARGET MUSCLE	REPITATION
1	ONE-LEG CIRCLE	Abdominal group, Gluteus Maximums & Hamstrings Muscles	5 circle each leg

2	ROLL- UP	Rectus Abdominus, Erector Spinae, Internal & External Oblique Muscles	5
3	SIT-UPS	Rectus Abdominus, Erector Spinae, Internal & External Oblique Muscles	10
4	HUNDRED	Sartorius, Abdominals, Quadriceps & Hamstring group of Muscles	10
5	SINGLE-LEG STRETCH	Rectus Abdominus, Internal Obliques & External Obliques	5 each leg
6	SINGLE STRAIGHT LEG STRETCH	Abdominals, Gluteus Maximus, Quadriceps & Hamstring group of Muscles	5 each leg
7	DOUBLE- LEG STRETCH	Rectus Abdominus, Internal Oblique & External Obliques, Iliopsoas Muscles	10

8	CRISSCROSS	Internal & External Oblique, Rectus & Transverses Abdominus Muscles	5 each leg
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Rest between exercises-: 10-20 seconds

Rest between set of exercise-: 45-60 seconds

VTH WEEK PILATES EXERCISE TRAINING

NO	EXERCISE	TARGET MUSCLE	REPETITION
1	SPINE STRETCH FORWARD	Rectus Abdominus, Erector Spinae, Internal & External Oblique Muscles	5
2	ROLLING LIKE A BALL	Internal & External Oblique, Rectus & Transverses Abdominus	10
3	SEAL PUPPY	Internal & External Oblique, Rectus & Transverse Abdominus Muscles	10

4	CRAB	Internal & External Oblique, Rectus & Transverse Abdominus	6
5	ROCKER WITH OPEN LEG	Abdominal Group, Iliopsoas, Rectus Femoris & Sartorius	6
6	ROLLOVER WITH LEG SPREAD	Abdominal Group, Iliopsoas, Rectus Femoris & Sartorius Muscles	6
7	BOOMERANG	Abdominal Group, Iliopsoas, Rectus Femoris & Sartorius Muscles	6
8	CONTROL BALANCE	Abdominal & Hamstrings Group, Gluteus Maximums, Erector Spinae, Muscles	3
9	JACKKNIFE	Abdominals, Quadriceps & Hamstring Group, Gluteus Maximums	5

Rest between exercises-: 10-20 seconds

Rest between set of exercise-: 45-60 seconds

VITH WEEKS PILATES EXERCISE TRAINING

NO	EXERCISE	TARGET MUSCLE	REPITITION -EACH LEG
1	SHOULDER BRIDGE	Erector Spinae, Semispinalis, Abdominals & Hamstring Group, Iliopsoas Muscle	5
2	SCISSORS	Erector Spinae, Semispinalis, Abdominal & Hamstrings Group, Iliopsoas Muscles	5
3	BICYCLE	Erector Spinae, Semispinalis, Abdominal & Hamstring Group, Iliopsoas & Sartorius	5
4	LEG PULL	Erector Spinae, Semispinal is, Abdominal & Hamstrings Group, Iliopsoas & Sartorius	5

5	LEG PULL FRONT	Internal & External Oblique, Rectus & Transverses Abdominus, Hamstring Group, Gluteus Maximums	5
6	PUSH UP	Internal & External Oblique, Rectus & Transverses Abdominus, Anterior Deltoid, Pectoralis Major, Biceps	5

Rest between exercises-: 10-20 seconds

Rest between set of exercise-: 45-60 seconds

GROUP-B

This group was trained with regular volleyball training which consists of warm-up and exercises session added with callisthenics training for 30 minutes which is done straight after the warm-up sessions.

CALLISTHENICS TRAINING FOR 6 WEEKS

I & II WEEKS CALLISTHENICS EXERCISE TRAINING

NO	EXERCISE	VARIATION OF EXERCISE	REPITITION
1	FREE HAND EXERCISES	5	2

III & IV WEEKS CALLISTHENICS EXERCISE TRAINING

NO	EXERCISE	EQUIPMENT	VARIATION	REPITITION
1	FREE HAND SERIES OF EXERCISE	NO EQUIPMENT	2	2
2	LIGHT DUMB-BELL SERIES	DUMB-BELL	5	2

V & VI WEEKS CALLISTHENICS EXERCISE TRAINING

NO	EXERCISE	EQUIPMENT	REPITITION	VARIATION
1	FREE HAND EXERCISES	NO EQUIPMENT	2	2
2	LIGHT DUMB-BELL EXERCISES	DUMB-BELL	2	2
3	STICK SERIES OF EXERCISES	DUMB-BELL	2	4

Rest between exercises-: 90 seconds,

Rest between set of exercise-:120 seconds.

GROUP-C

This group was trained with regular volleyball training which consists of warm-up and exercises session added with plyometric training for 30 minutes which is done straight after the warm-up sessions.

PLYOMETRIC TRAINING FOR 6 WEEKS

WEEK	DRILL	SETS x REPS
1	SIDE TO SIDE ANKLE HOPS	2 X 15
	STANDING JUMP AND REACH	2 X 15
	FRONT CONE HOPS	5 X 6
2-3	SIDE TO SIDE ANKLE HOPS	2 X 15
	STANDING JUMP	5 X 6
	LATERAL JUMP BARRIER	2 X 15
	DOUBLE LEG HOPS	5 X 8
	LATERAL CONE HOPS	2 X 12
4-5	DIAGONAL CONE HOPS	4 X 8
	LATERAL SPRINT	4 X 8
	LATERAL CONE HOPS	4 X 12
	SINGLE LEG BOUNDING	4 X 7
	LATERAL JUMP SINGLE LEG	4 X 7
6	DIAGONAL CONE HOPS	2 X 12
	HEXAGONAL DRILL	2 X 12
	CONE HOPS WITH CHANGE	
	OF DIRECTION SPRINT	4 X 6
	DOUBLE LEG HOPS	3 X 8
	LATERAL JUMP SINGLE LEG	4 X 6

3.9 STATISTICAL TOOLS:

The following statistical tools were used to compare pre and post test values of three groups.

One way analysis of variance ANOVA was used to compare the difference within the group. The paired “t test” was used to compare the pre and post test values within the Group. The unpaired “t” test was used to compare the post test values between the groups A,B and C.

Formula - ONE WAY ANOVA

$$F = \frac{\text{Mean square between samples}}{\text{Mean square within samples}}$$

Where , F = variance ratio

Formula - Paired t test

$$S = \sqrt{\frac{\sum d^2 - \left(\frac{\sum d}{n}\right)^2}{n-1}}$$
$$t = \frac{\bar{d} \sqrt{n}}{S}$$

Where,

d = Difference between the pre – test and post – test values.

\bar{d} = Mean difference.

n = Total number of patients.

S = Standard Deviation.

$\sum d^2$ = Sum of the squared deviation.

Formula – Unpaired t test

The Unpaired “t test” was used to compare the post test values of Group A and B.

$$S = \sqrt{\frac{\sum (X_1 - \bar{X}_1)^2 + \sum (X_2 - \bar{X}_2)^2}{n_1 + n_2 - 2}}$$
$$t = \frac{\bar{X}_1 - \bar{X}_2}{S} \sqrt{\frac{n_1 n_2}{n_1 + n_2}}$$

Where,

\bar{X}_1 = Mean of Group A.

\bar{X}_2 = Mean of Group B.

\sum = Sum of the values.

n_1 = Number of patients in Group A.

n_2 = Number of patients in Group B.

S = Standard Deviation.

X_1 = Difference between pre - test and post - test of Group A.

X_2 = Difference between pre - test and post - test of Group B.

Level of significance = 0.05 %.

IV DATA ANALYSIS AND INTERPRATATION

TABLE-I

**One Way ANOVA for pre test values of flying 30m sprint
between groups**

SOURCE	DF	SS	MS	F VALUE
BETWEEN GROUPS	2	0.0812	0.0406	0.3265
ERROR	42	5.2261	0.1244	
TOTAL	44	5.3074		

The observed f ratio is not in the critical region (3.3438) so that the null hypothesis is accepted which indicates that there is no significant difference between the groups on the outcome parameter flying 30m sprint.

TABLE-II

**One Way ANOVA for post test values of flying 30m sprint
between groups**

SOURCE	DF	SS	MS	F VALUE
BETWEEN GROUPS	2	0.2482	0.1241	1.3043
ERROR	42	3.9966	0.0952	
TOTAL	44	4.2449		

The observed f ratio is not in the critical region (3.3438) so that the null hypothesis is not accepted which indicates that there is a significant difference between the groups on the outcome parameter flying 30m sprint.

TABLE-III

One Way ANOVA for pre test values of Illinois agility test
between groups

SOURCE	DF	SS	MS	F VALUE
BETWEEN GROUPS	2	0.5021	0.251	1.0129
ERROR	42	10.36	0.246	
TOTAL	44	10.87		

The observed f ratio is not in the critical region (3.3438) so that the null hypothesis is accepted which indicates that there is no significant difference between the groups on the outcome parameter Illinois agility test.

TABLE-IV

**One Way ANOVA for post test values of Illinois agility test
between groups**

SOURCE	DF	SS	MS	F VALUE
BETWEEN GROUPS	2	8.0801	4.04	20.82
ERROR	42	8.1494	0.194	
TOTAL	44	16.2295		

The observed f ratio is not in the critical region (3.3438) so that the null hypothesis is not accepted which indicates that there is a significant difference between the groups on the outcome parameter Illinois agility test.

TABLE-V

**One Way ANOVA for pre test values of sit and reach test
between groups**

SOURCE	DF	SS	MS	F VALUE
BETWEEN GROUPS	2	2.711	1.355	0.1242
ERROR	42	458.26	10.911	
TOTAL	44	460.97		

The observed f ratio is not in the critical region (3.3438) so that the null hypothesis is accepted which indicates that there is no significant difference between the groups on the outcome parameter sit and reach test.

TABLE-VI

**One Way ANOVA for post test values of Sit and reach test
between groups**

SOURCE	DF	SS	MS	F VALUE
BETWEEN GROUPS	2	90.71	45.356	4.0257
ERROR	42	473.20	11.266	
TOTAL	44	563.91		

The observed f ratio is not in the critical region (3.3438) so that the null hypothesis is not accepted which indicates that there is a significant difference between the groups on the outcome parameter Sit and reach test.

TABLE-VII

One Way ANOVA for pre test values of Vertical jump test
between groups

SOURCE	DF	SS	MS	F VALUE
BETWEEN GROUPS	2	4.8	2.42	0.0918
ERROR	42	1108.13	26.38	
TOTAL	44	1112.98		

The observed f ratio is not in the critical region (3.3438) so that the null hypothesis is accepted which indicates that there is no significant difference between the groups on the outcome parameter Vertical jump test.

TABLE-VIII

One Way ANOVA for post test values of Vertical jump test
between groups

SOURCE	DF	SS	MS	F VALUE
BETWEEN GROUPS	2	465.6	232.8	8.2
ERROR	42	1183.6	28.18	
TOTAL	44	1649.2		

The observed f ratio is not in the critical region (3.3438)so that the null hypothesis is not accepted which indicates that there is a significant difference between the groups on the outcome parameter Vertical jump test.

TABLE-IX

FLYING 30m SPRINT TEST

PAIRED 't' TEST – GROUP A- PILATES

GROUP A	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	't' VALUE
PRE TEST	4.43	0.18	0.267	6.4411
POST TEST	4.25			

Calculated 't' value 6.4411 is greater than table value 2.145 at 0.05%level of significance. There is significant difference between two means of group A

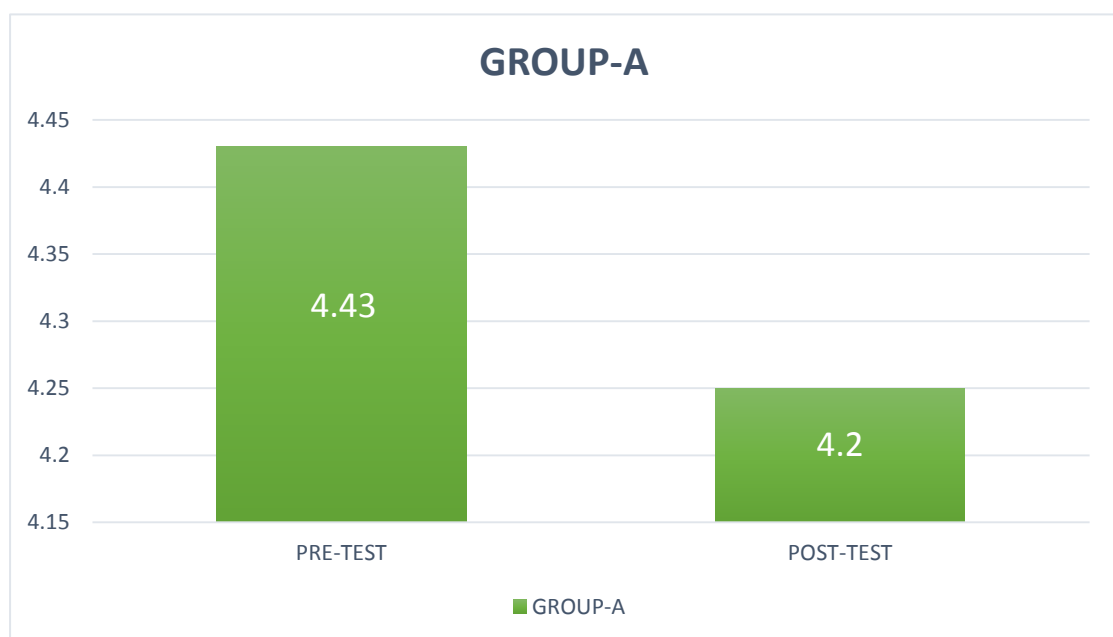


TABLE-X

FLYING 30M SPRINT TEST

PAIRED 't' TEST – GROUP B-CALLISTHENICS

GROUP B	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	't' VALUE
PRE TEST	4.34	0.07	0.372	4.7845
POST TEST	4.27			

Calculated 't' value 4.7845 is greater than table value 2.145 at 0.05% level of significance. There is a significant difference between two means of group B.

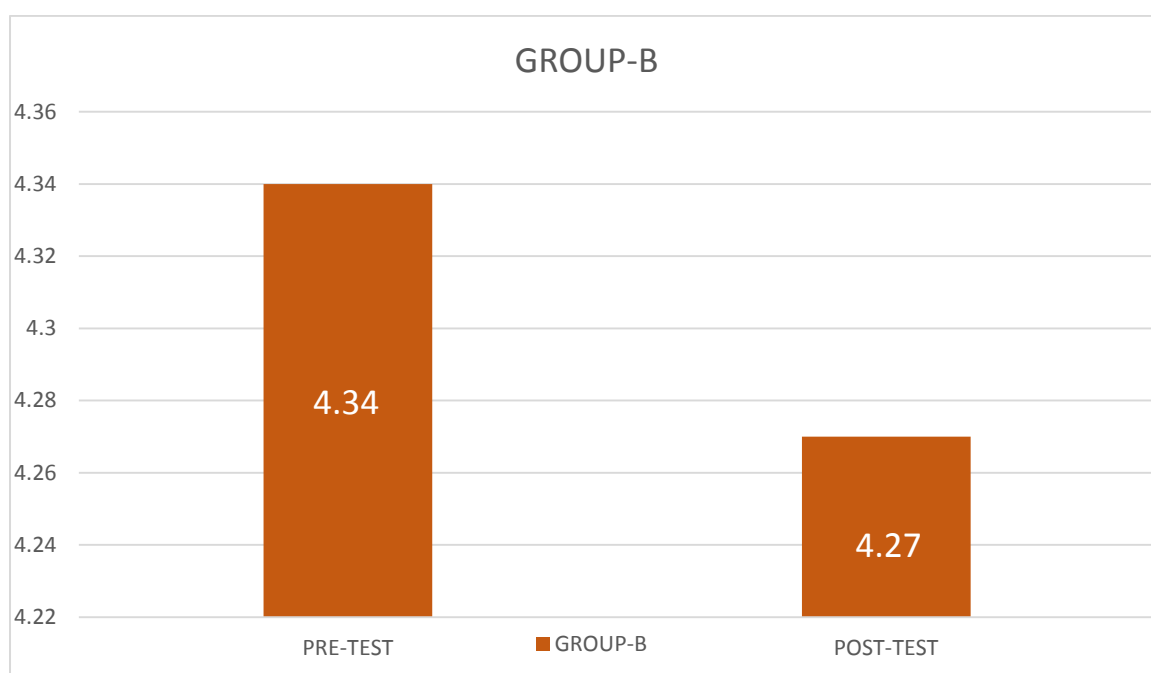


TABLE-XI

FLYING 30M SPRINT TEST

PAIRED 't' TEST – GROUP C- PLYOMETRICS

GROUP C	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	't' VALUE
PRE TEST	4.4	0.3	0.267	13.2288
POST TEST	4.1			

Calculated 't' value 13.2288 is greater than table value 2.145 at 0.05% level of significance. There is a significant difference between two means of group C.

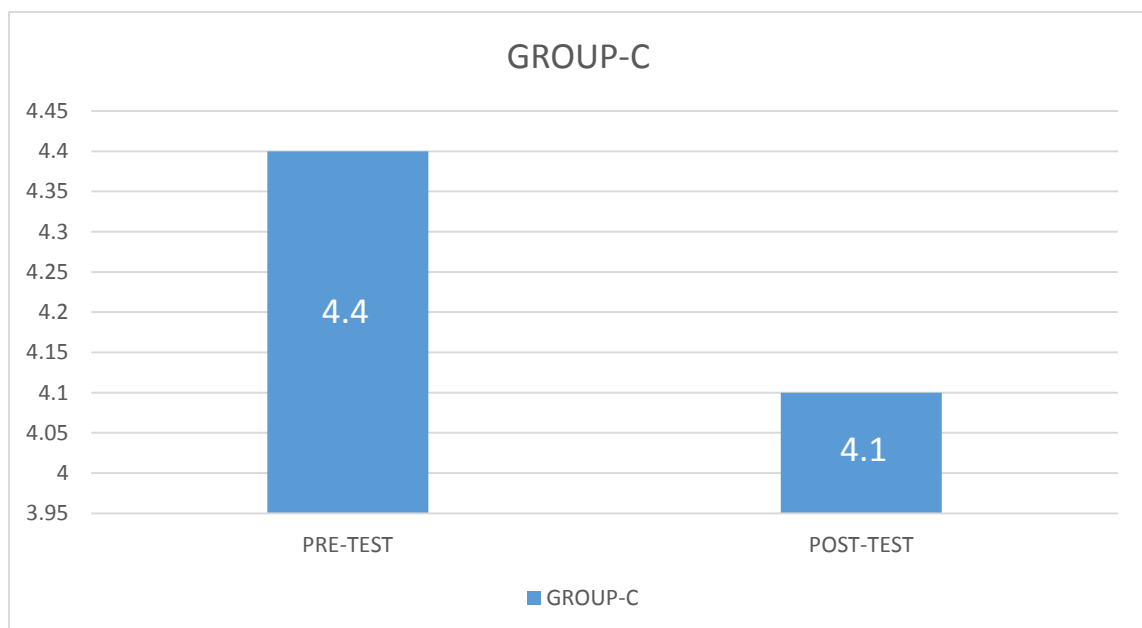


TABLE-XII

ILLINOIS AGILITY TEST

PAIRED ‘t’ TEST – GROUP A- PILATES

GROUP A	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	‘t’ VALUE
PRE TEST	19.53	0.21	0.549	5.0328
POST TEST	19.32			

Calculated ‘t’ value 5.0328 is greater than table value 2.145 at 0.05% level of significance. There is a significant difference between two means of group A.

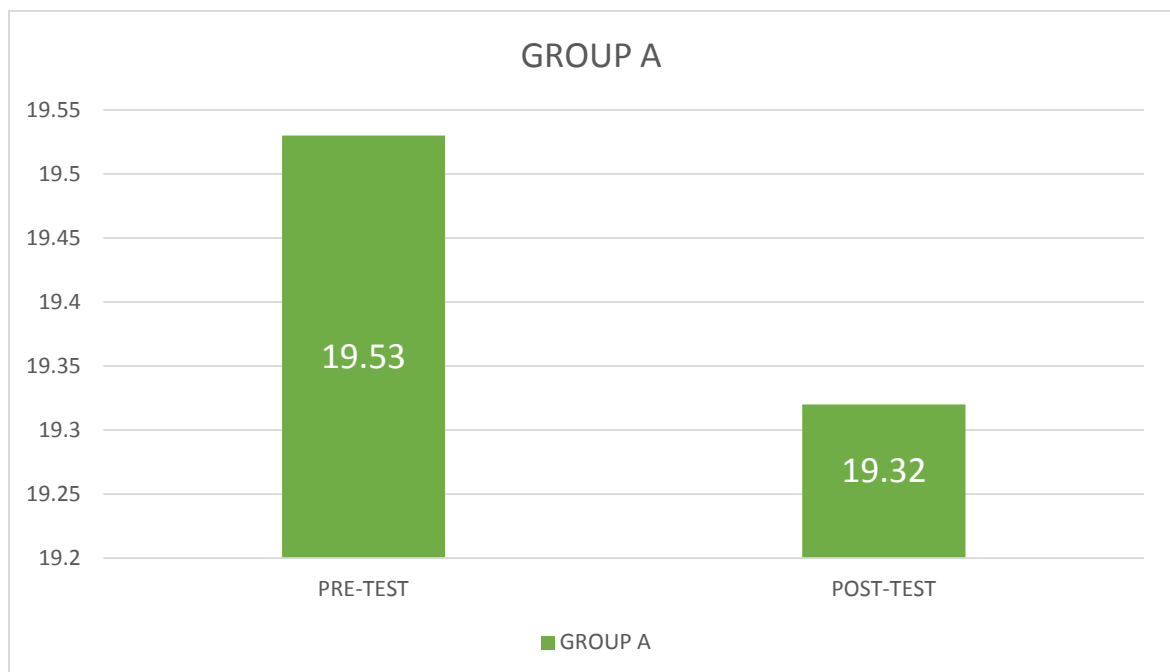


TABLE-XIII

ILLINOIS AGILITY TEST

PAIRED ‘t’ TEST – GROUP B-CALLISTHENICS

GROUP B	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	‘t’ VALUE
PRE TEST	19.51	0.12	0.48	6.87
POST TEST	19.39			

Calculated ‘t’ value 6.87 is greater than table value 2.145 at 0.05% level of significance. There is a significant difference between two means of group B.

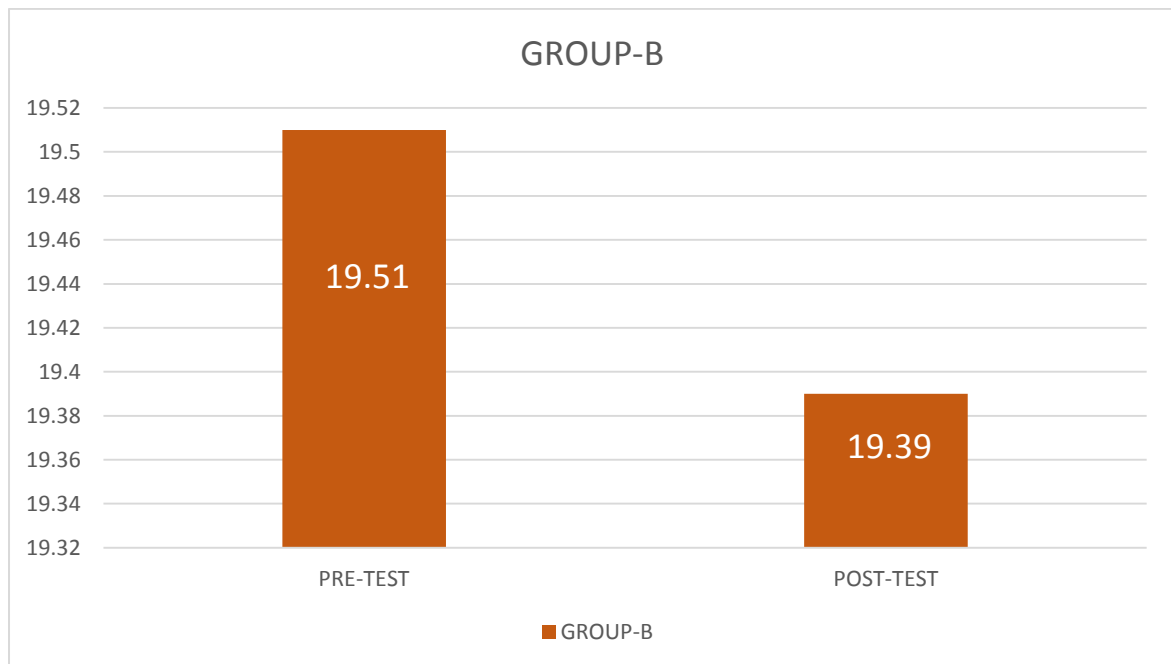


TABLE-XIV

ILLINOIS AGILITY TEST

PAIRED ‘t’ TEST – GROUP C- PLYOMETRICS

GROUP C	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	‘t’ VALUE
PRE TEST	19.76	1.30	0.511	8.4760
POST TEST	18.46			

Calculated ‘t’ value 8.4760 is greater than table value 2.145 at 0.05% level of significance. There is a significant difference between two means of group C.

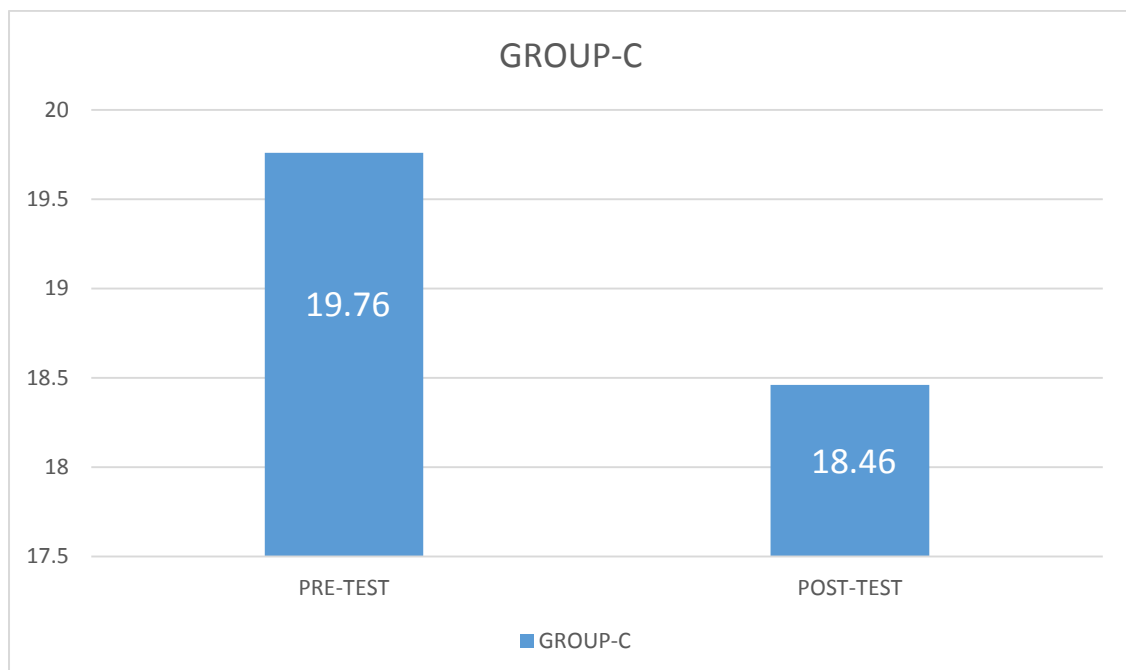


TABLE-XV

SIT AND REACH TEST

PAIRED 't' TEST – GROUP A- PILATES

GROUP A	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	't' VALUE
PRE TEST	18.2	4.6	3.24	15.8895
POST TEST	22.8			

Calculated 't' value 15.8895 is greater than table value 2.145 at 0.05% level of significance. There is a significant difference between two means of group A.

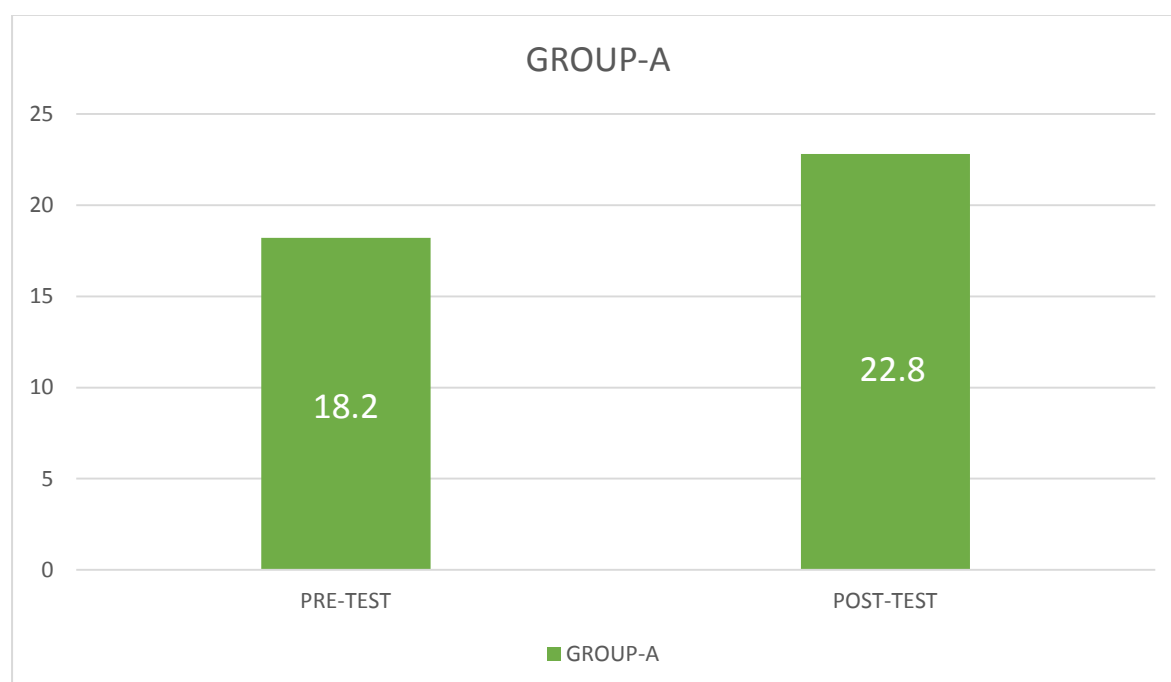


TABLE-XVI

SIT AND REACH TEST

PAIRED 't' TEST – GROUP B-CALLISTHENICS

GROUP B	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	't' VALUE
PRE TEST	17.73	1.67	5.49	3.1066
POST TEST	19.4			

Calculated 't' value 3.1066 is greater than table value 2.145 at 0.05% level of significance. There is a significant difference between two means of group B.

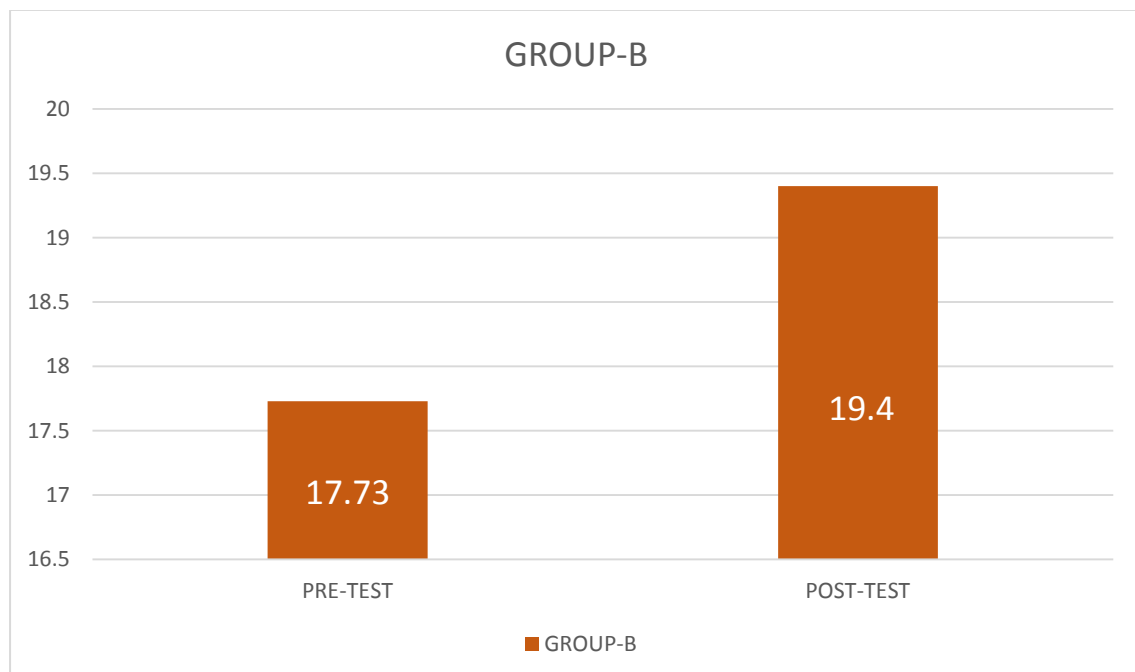


TABLE-XVII

SIT AND REACH TEST

PAIRED 't' TEST – GROUP C- PLYOMETRICS

GROUP C	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	't' VALUE
PRE TEST	18	2.5	0.80	9.4309
POST TEST	20.5			

Calculated 't' value 9.4309 is greater than table value 2.145 at 0.05% level of significance. There is a significant difference between two means of group C.

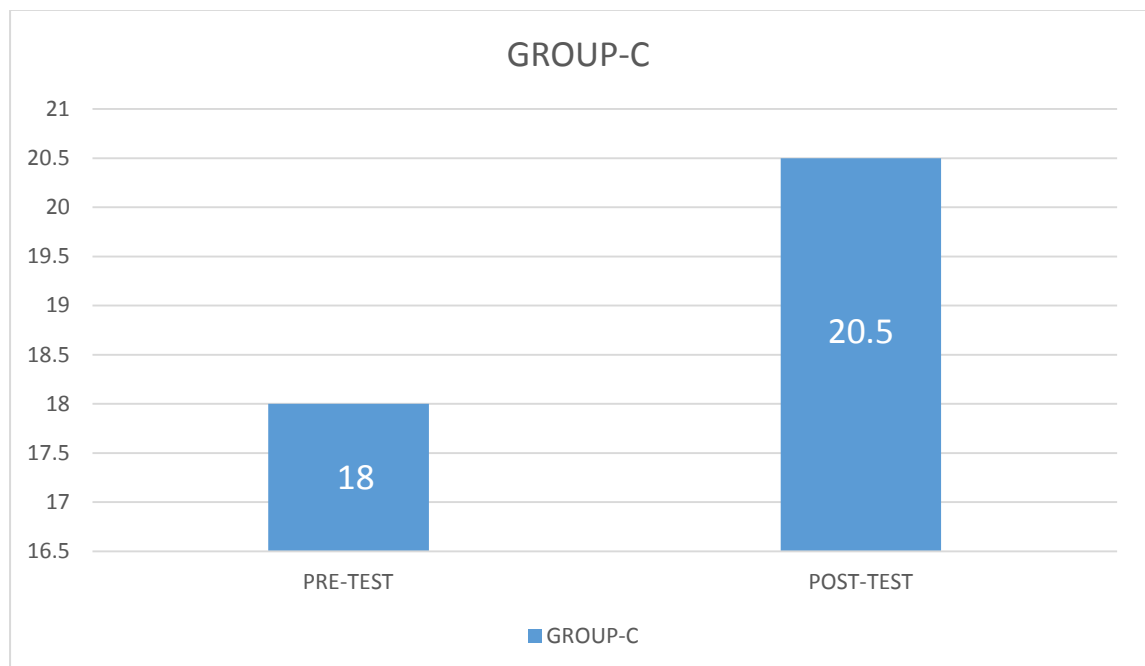


TABLE-XVIII
VERTICAL JUMP TEST
PAIRED ‘t’ TEST – GROUP A- PILATES

GROUP A	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	‘t’ VALUE
PRE TEST	42.9	3.1	5.13	10.2132
POST TEST	46			

Calculated ‘t’ value 10.2132 is greater than table value 2.145 at 0.05% level of significance. There is a significant difference between two means of group A.

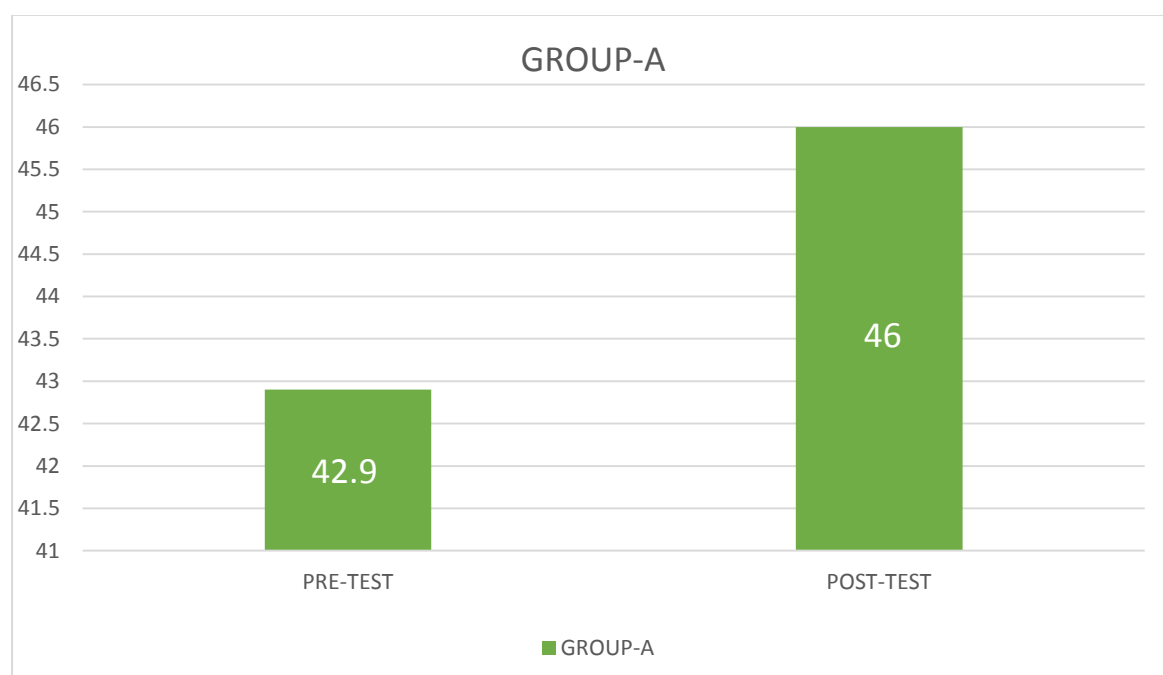


TABLE-XIX**VERTICAL JUMP TEST****PAIRED ‘t’ TEST – GROUP B- CALLISTHENICS**

GROUP B	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	‘t’ VALUE
PRE TEST	42.6	1.4	4.69	4.00
POST TEST	44			

Calculated ‘t’ value 4.00 is greater than table value 2.145 at 0.05% level of significance. There is a significant difference between two means of group B.

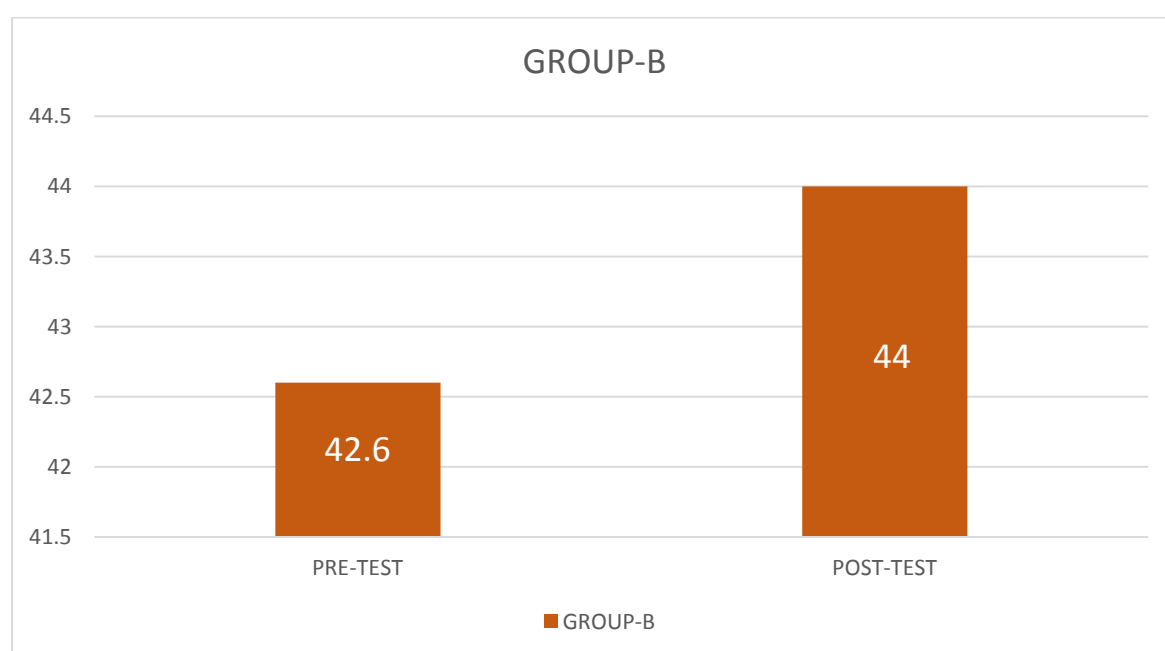


TABLE-XX

VERTICAL JUMP TEST

PAIRED 't' TEST – GROUP C- PLYOMETRICS

GROUP C	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	't' VALUE
PRE TEST	43.4	8.2	6.02	16.7382
POST TEST	51.6			

Calculated 't' value 16.7382 is greater than table value 2.145 at 0.05% level of significance. There is significant difference between two means of group C.

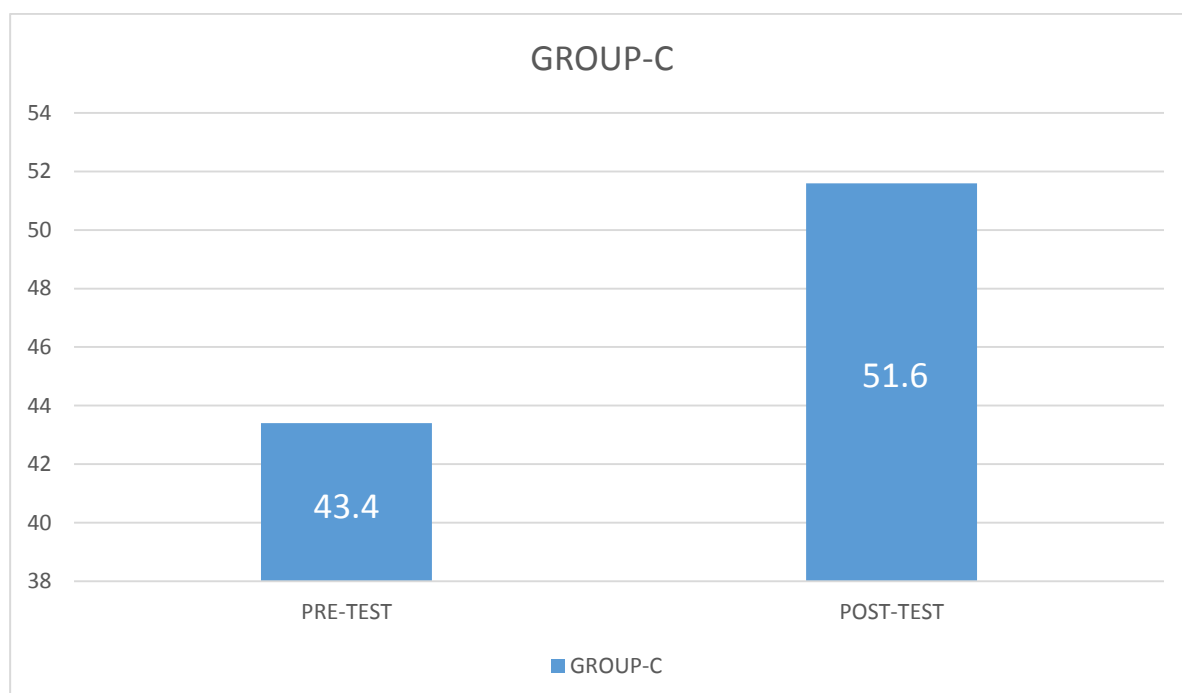


TABLE-XXI

FLYING 30M SPRINT TEST

UNPAIRED 't' TEST – POST TEST VALUES GROUP A VS B

GROUP	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	't' VALUE
A	4.25	0.02	0.35	0.1570
B	4.27			

Calculated 't' value 0.1570 is not greater than table value 2.048 at 0.05% level of significance showing that there is no significant difference between two groups. Thereby players in both groups showed improvement which is not much significant. The means of values showed there is a little improvement in group A on comparing with group B.

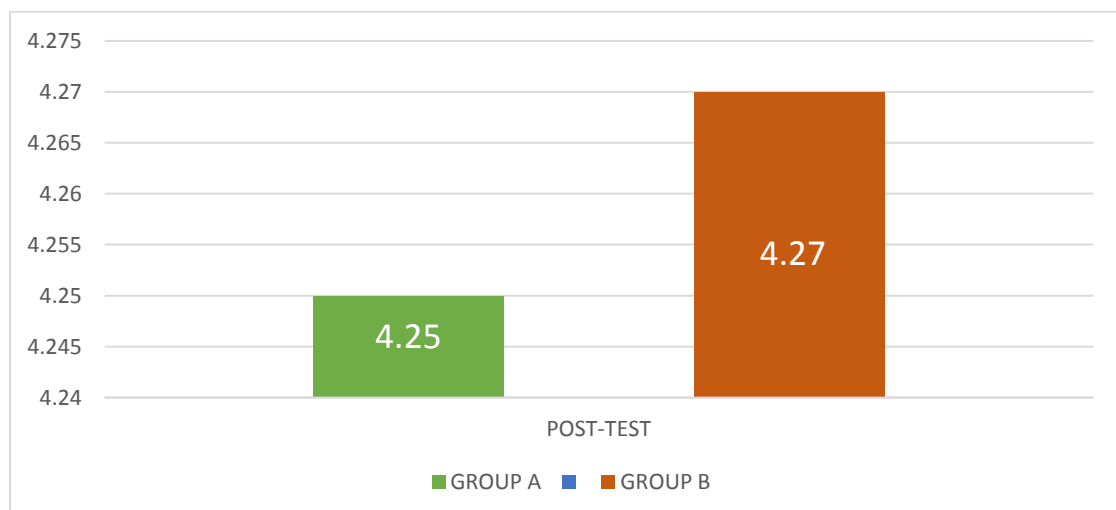


TABLE-XXII

FLYING 30M SPRINT TEST

UNPAIRED 't' TEST – POST TEST VALUES GROUP A VS C

GROUP	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	't' VALUE
A	4.25	0.15	0.344	1.3785
C	4.10			

Calculated 't' value 1.3785 is not greater than table value 2.048 at 0.05% level of significance showing that there is no significant difference between two groups. Thereby players in both groups showed improvement which is not much significant. The means of values showed there is a little improvement in group C on comparing with group A.

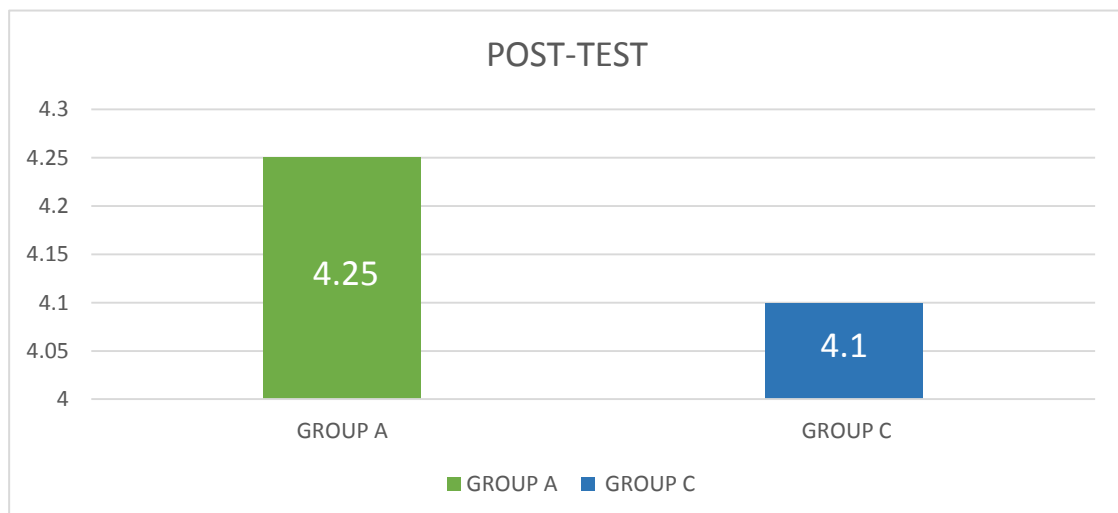


TABLE-XXIII**FLYING 30M SPRINT TEST****UNPAIRED 't' TEST – POST TEST VALUES GROUP B VS C**

GROUP	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	't' VALUE
B	4.27	0.17	0.353	1.5793
C	4.10			

Calculated 't' value 1.5793 is not greater than table value 2.048 at 0.05% level of significance showing that there is no significant difference between means of two groups. Thereby players in both groups showed improvement which is not much significant. The means of values showed there is a little improvement in group C comparing with group B.

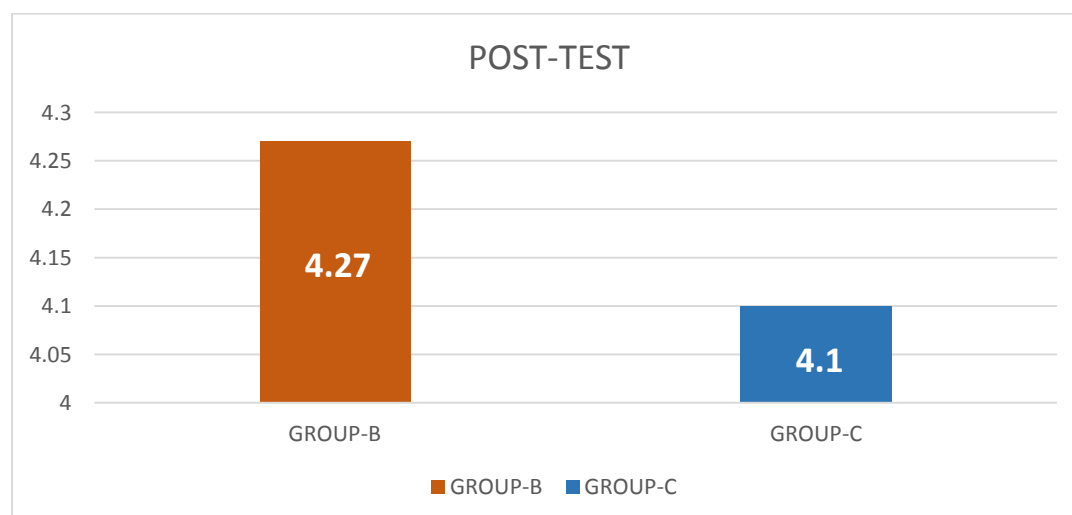


TABLE-XXIV

ILLINOIS AGILITY TEST

UNPAIRED ‘t’ TEST – POST TEST VALUES GROUP A VS B

GROUP	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	‘t’ VALUE
A	19.32	0.02	0.549	0.3898
B	19.3			

Calculated ‘t’ value 0.3898 is not greater than table value 2.048 at 0.05% level of significance showing that there is no significant difference between means of two groups. Thereby players in both groups showed improvement which is not much significant. The mean of values showed a little improvement in group B on comparing with group A.

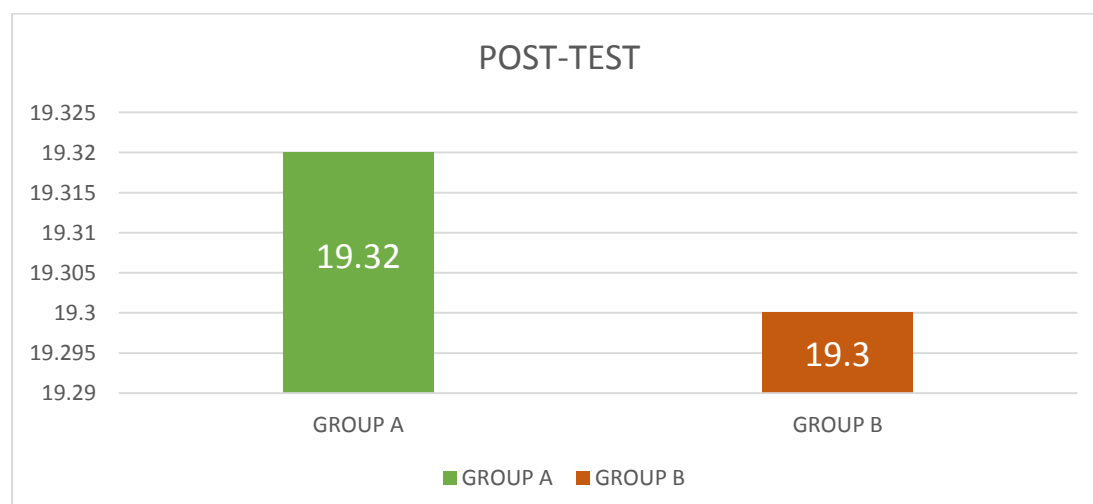


TABLE-XXV

ILLINOIS AGILITY TEST

UNPAIRED ‘t’ TEST – POST TEST VALUES GROUP AVS C

GROUP	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	‘t’ VALUE
A	19.3	0.84	0.549	5.6072
C	18.46			

Calculated ‘t’ value 5.6072 is greater than the table value 2.048 at 0.05% level of significance showing that there is a significant difference between means of two groups. Thereby players in both groups showed improvement in comparison group C showed a good improvement than group A.

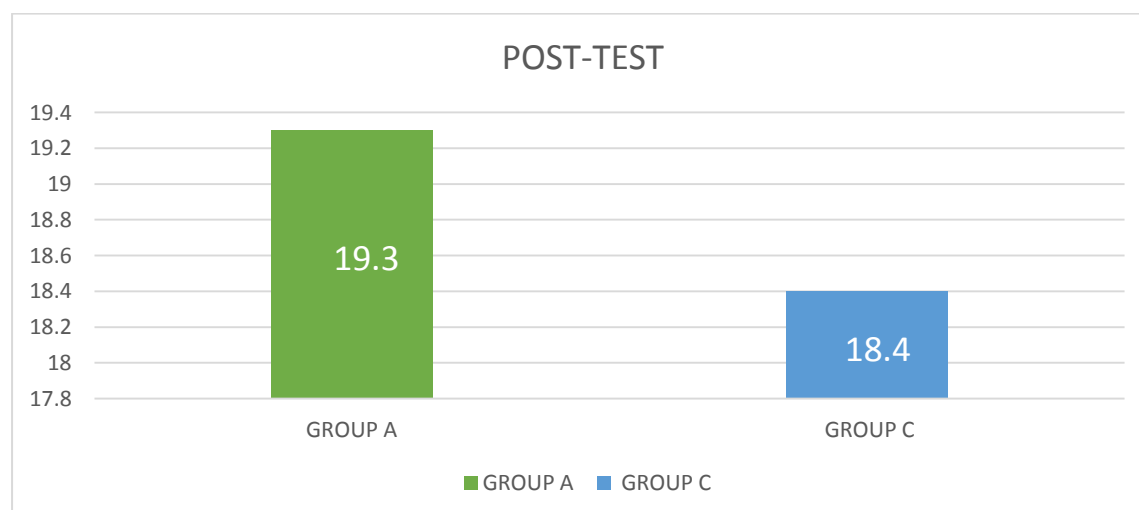


TABLE-XXVI

ILLINOIS AGILITY TEST

UNPAIRED ‘t’ TEST – POST TEST VALUES GROUP B VS C

GROUP	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	‘t’ VALUE
B	19.3	0.09	0.479	6.8267
C	18.4			

Calculated ‘t’ value 6.8267 is greater than table value 2.048 at 0.05% level of significance showing that there is a significant difference between means of two groups. Thereby players in both groups showed improvement in comparison group C showed good improvement than groupB.

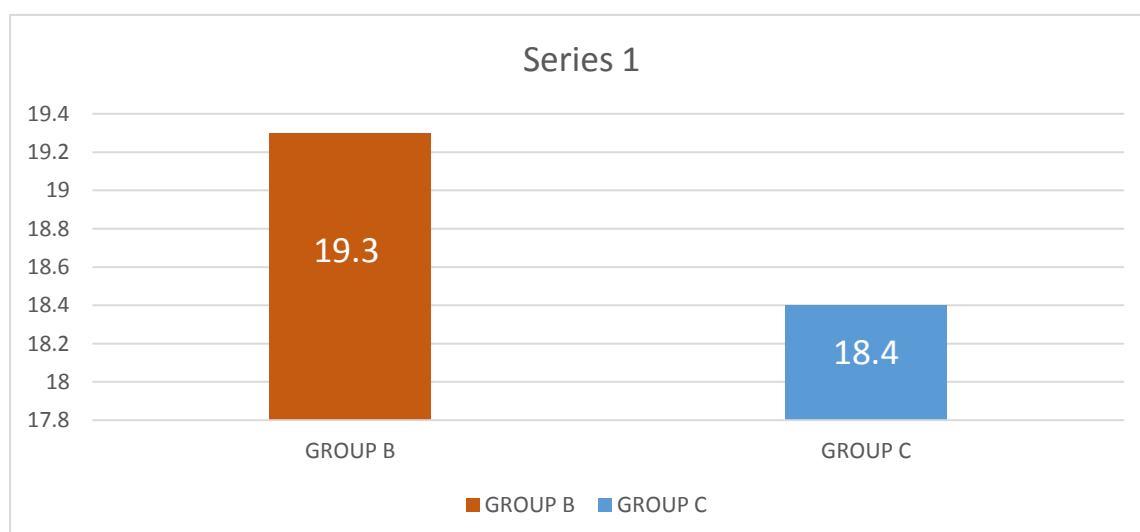


TABLE-XXVII

SIT AND REACH TEST

UNPAIRED ‘t’ TEST – POST TEST VALUES GROUP A VS B

GROUP	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	‘t’ VALUE
A	22.8	3.4	3.72	2.7311
B	19.4			

Calculated ‘t’ value 2.7311 is greater than table value 2.048 at 0.05% level of significance showing that there is a significant difference between means of two groups. Thereby players in both groups showed improvement in which group A showed greater improvement on comparing with group B.

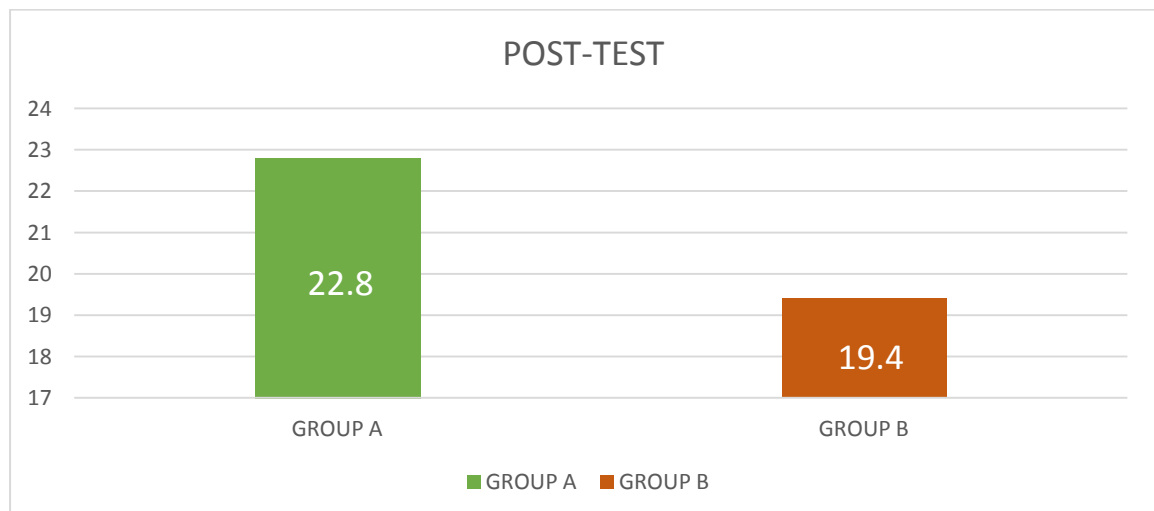


TABLE-XXVIII

SIT AND REACH TEST

UNPAIRED 't' TEST – POST TEST VALUES GROUP A VS C

GROUP	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	't' VALUE
A	22.8	2.3	3.09	2.1944
C	20.5			

Calculated 't' value 2.1944 is greater than table value 2.048 at 0.05% level of significance showing that there is a significant difference between means of two groups. Thereby players in both groups showed improvement in which group A showed greater improvement on comparing with group C.

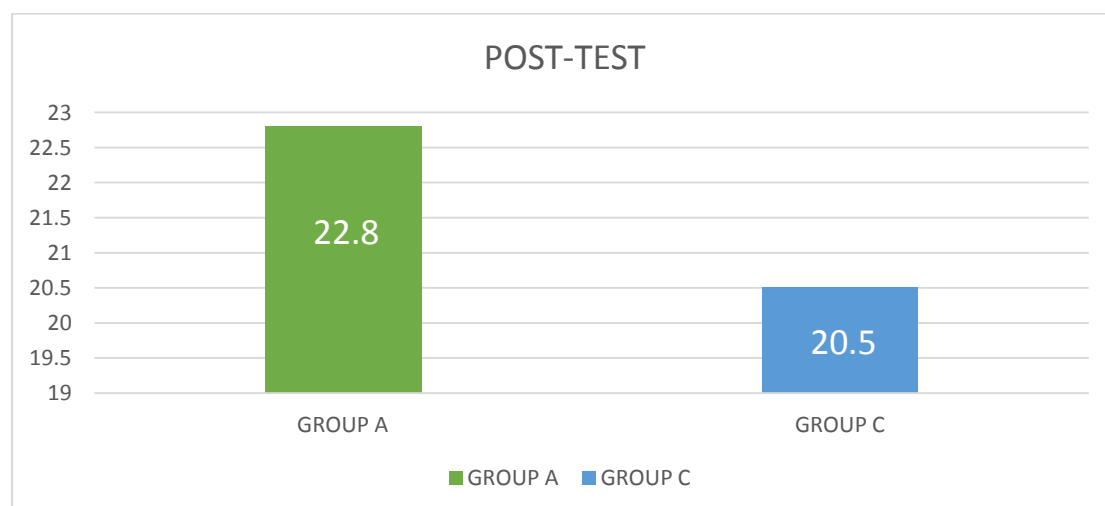


TABLE-XXIX

SIT AND REACH TEST

UNPAIRED 't' TEST – POST TEST VALUES GROUP B VS C

GROUP	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	't' VALUE
B	19.4	1.1	3.72	0.7476
C	20.5			

Calculated 't' value 0.7476 is not greater than table value 2.048 at 0.05% level of significance showing that there is no significant difference between means of two groups. Thereby players in both groups showed improvement in which group C showed greater improvement on comparing with group B.

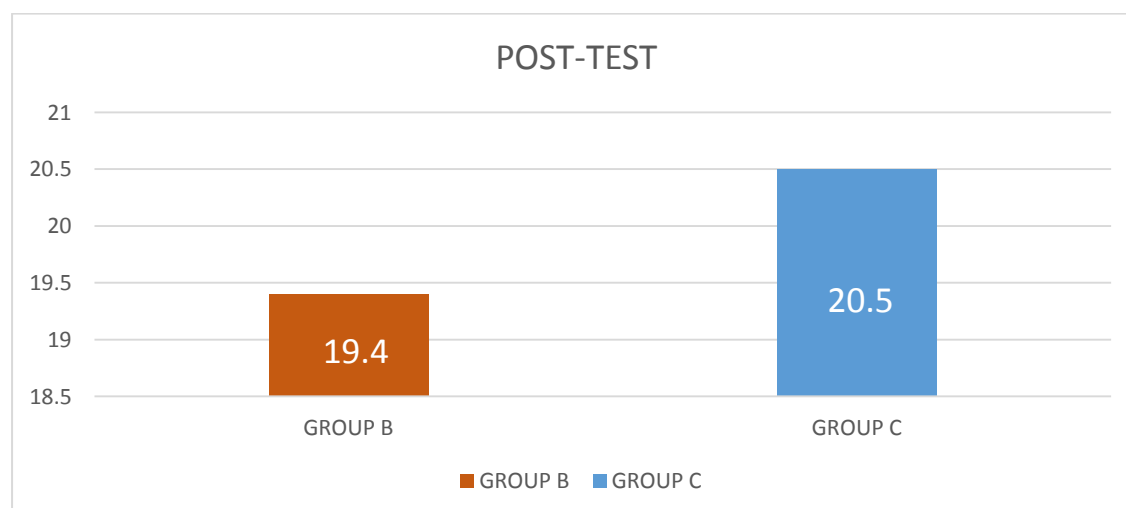


TABLE-XXX

VERTICAL JUMP TEST

UNPAIRED ‘t’ TEST – POST TEST VALUES GROUP A VS B

GROUP	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	‘t’ VALUE
A	46.6	2.6	5.13	1.1147
B	44			

Calculated ‘t’ value 1.1147 is not greater than table value 2.048 at 0.05% level of significance showing that there is no significant difference between means of two groups. Thereby players in both groups showed improvement in which group A showed greater improvement on comparing with group B.

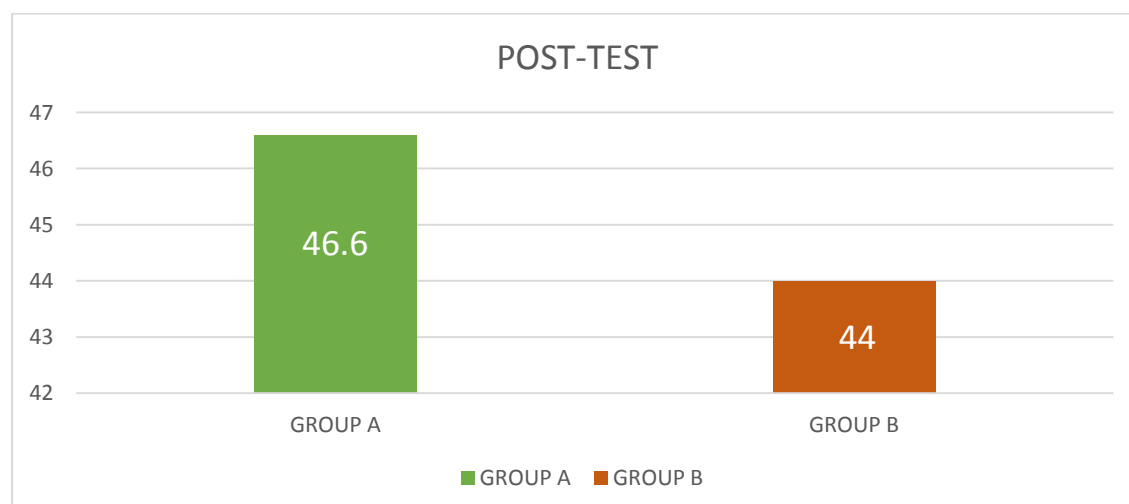


TABLE-XXXI**VERTICAL JUMP TEST****UNPAIRED 't' TEST – POST TEST VALUES GROUP A VS C**

GROUP	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	't' VALUE
A	46.6	5	5.13	2.7425
C	51.6			

Calculated 't' value 2.7425 is greater than table value 2.048 at 0.05% level of significance showing that there is a significant difference between means of two groups. Thereby players in both groups showed improvement in which group C showed greater improvement on comparing with group A.

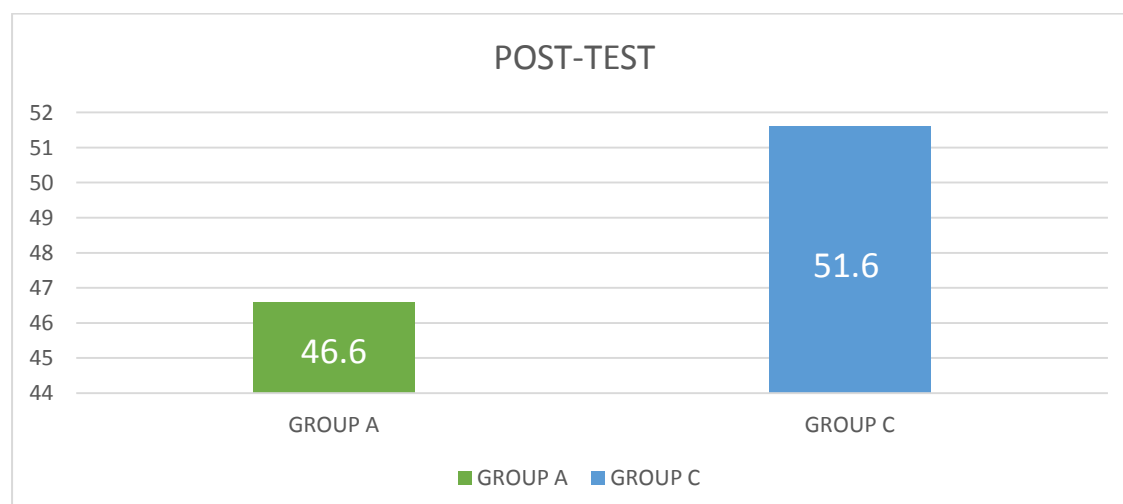


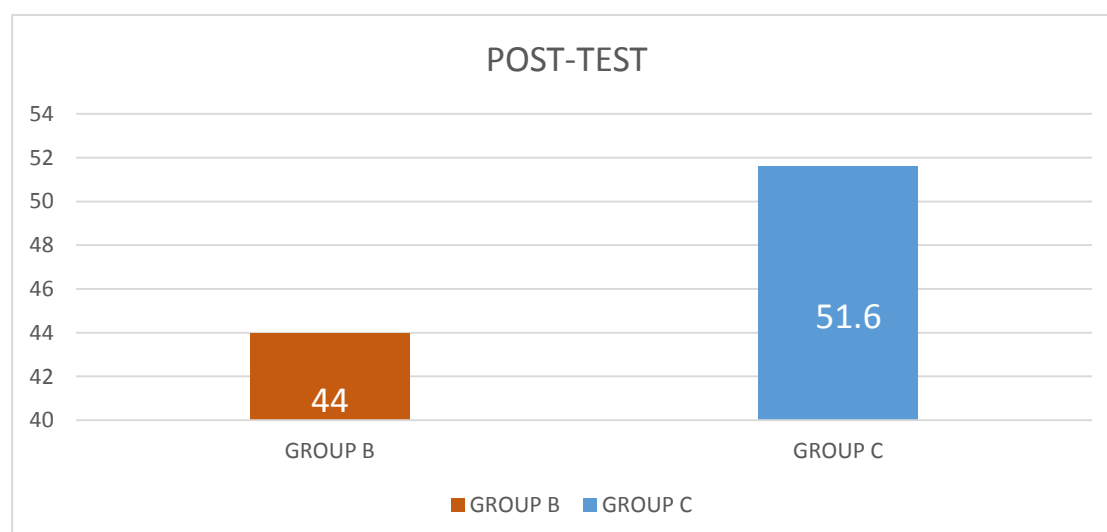
TABLE-XXXII

VERTICAL JUMP TEST

UNPAIRED ‘t’ TEST – POST TEST VALUES GROUP B VS C

GROUP	MEAN	MEAN DIFFERENCE	STANDARD DEVIATION	‘t’ VALUE
B	44	7.6	6.02	3.8564
C	51.6			

Calculated ‘t’ value 3.8564 is not greater than table value 2.048 at 0.05% level of significance showing that there is a significant difference between means of two groups. Thereby players in both groups showed improvement in which group C showed greater improvement on comparing with group B.



V DISCUSSION

The main aim of this study is to compare the different training technique in the improvement of performance among the collegiate volleyball players. The major components of fitness assessed in this study were power, flexibility, speed and agility. Because these are the most important components to be trained for the volleyball players.

The tests used to calculate the baseline value and the post training values for the fitness variables are 30m sprint test, Illinois agility test, sit and reach test and vertical jump test.

A volley ball player should be always ready inside the field to do activities such as short sprint inside or around the court, rapidly change direction during sprinting, should be flexible enough to stretch and reach the ball which is away from him and to perform an explosive jump in no time to attack or block the ball. So there by improving these components will improve the performance of a volleyball player.

The total of 45 active collegiate volleyball players who satisfy inclusion and exclusion criteria were taken and divided into three groups equally of 15 in each group. All the players were assessed with fitness tests mentioned above for pre training and post training measurements.

In this study the results were analysed by using SPSS20. ANOVA was used to compare the difference in test values within the groups. Paired ‘t’ test was used to calculate the mean and standard deviation within the group’s for the pre and post test values. Unpaired ‘t’ test was used to analyse the difference between means and standard deviation of post test values between the groups.

Result of the ANOVA shows that there is no significant differences in the pre test values of the fitness tests. The results were shown in Tables 1, 3, 5 & 7. This result shows that the baseline values of all the subjects were same in their performances.

Results of the ANOVA show that there is a significant difference in the post test values of the test done within the groups. The results were shown in tables 2, 4, 6 & 8. This result shows that the post training values of all the subjects within the groups had a difference in their performances after the training session.

The results of Tables 9, 10, 11 shows the results of paired ‘t’ test values of flying 30m sprint test and tables 21, 22, 23 shows the result of unpaired ‘t’ test which compares the post test values of fitness tests done. These clearly show all three groups show minimal improvement in sprint performance, which is not much significant on comparing with the tabulated table values.

The ability to recover quickly in order to perform subsequent sprints is an important fitness requirement that has been termed repeated sprint ability in volley ball players. By applying plyometrics, pilates and callisthenics this study suggest that the above mentioned component have no significant change in it. The findings suggest that these training may not suffice for the improvement of sprinting capacities of volleyball players. The reason may be because of inadequate to induce significant central and/or peripheral adaptations for improvements in VO₂max.

Tables 12, 13, 14 shows results of paired ‘t’ test values of Illinois agility test and tables 24, 25, 26 shows this result of unpaired ‘t’ test which compares the post test values of all three groups. On comparing the values, group C (plyometric training group) showed significant difference among three groups in the fitness variable agility.

Agility plays a key role in volley ball player since it helps in immediate turn and recovery in the game. It seems to be related to athletic abilities like strength, power, speed and balance and it's a determinant of sport performance in field and court sports like volleyball, soccer and rugby(Gortsila, E,2013). After the training of plyometrics, pilates and callisthenics this study shows and suggest that the plyometric training has significant improvement than the other two training in agility.

Dimas Sondang Irawan et al,2017 had the same effect in their study and suggest that Plyometric movements are components that can help in improving agility because it exploits the adaptation of stretch-shortening cycles through the neuromuscular system in helping to increase leg muscle power so agility improvement can be achieved.

Tables 15, 16, 17 shows paired ‘t’ test results of sit and reach test and tables 27, 28, 29 shows results of Unpaired ‘t’ test. On comparing the table values it is clearly visible that the group A(Pilates training) showed significant difference in the fitness variable flexibility.

Flexibility is a crucial element of fitness to gain optimal musculoskeletal function enhancing peak performance (Sureeporn Phrompaet et al,2010). After the training of Plyometrics, Pilates and Callisthenics this study demonstrates that Pilates has better improvement than the other two training in flexibility test. In support to this study (Kerim Sozbir et al,2016) in their study stated that Pilates exercise involves stretching the muscles immediately before making rapid concentric contractions . This combined action is commonly called a stretch-shortening cycle and depends on using passively elastic energy in the muscle and the active role of stretch reflex.

Tables 18, 19, 20 shows paired “t” test results of vertical jump test and tables 30, 31, 32 shows result of Unpaired “t” test. On comparing the table values it is clear seen that group C (Plyometric training) showed significant difference in the fitness variable power.

After the training of Plyometrics, Pilates and Callisthenics this study demonstrates that Plyometrics has better improvement than the other two training in lower limb power test. (Meylan & Malatesta, 2009) supports this result stating that, In Plyometrics the muscle function is drawn before concentric contraction is maximized, followed by rapid movement from the eccentric phase to the concentric which helps stimulate the proprioceptors to facilitate increased muscle recruitment in a minimal amount of time.

Therefore, the results of the study concludes that training three groups with Pilates, Callisthenics and Plyometrics on sprint showed very less improvement in all groups which is not much significant, In flexibility (group A) Pilates group showed significant improvement and in parameters like agility and power the Plyometrics group(group C)showed significant improvement.

VI SUMMARY AND CONCLUSION

The purpose of this study is to find the effects of Pilates, Callisthenics and Plyometrics and to compare the effects of the above training techniques in sports fitness components like sprint, agility, flexibility and power in collegiate volleyball players.

Sprint was measured by flying 30m sprint test, Agility test done using Illinois agility test, Flexibility measured using Sit and reach test and Power was measured by using Vertical jump test

45 subjects who fulfilled inclusion and exclusion criteria were taken and divided into three Groups of equal numbers using simple random sampling method. Three groups underwent Pilates, Callisthenics and Plyometric training correspondingly.

The study rejects the null hypothesis and therefore suggests that there is a significant improvement in Plyometric training for agility and power comparing with other two techniques, whereas Pilates improves flexibility on comparing with other two techniques. The study also accepts the null hypothesis and therefore suggests that there is no significant difference between all the three groups in sprinting component.

VII LIMITATIONS AND RECOMMENDATIONS

LIMITATIONS:

- The Study was conducted on a smaller sample size.
- The Study only focuses on collegiate volleyball players.
- The Study focuses on three training techniques only.
- This study includes only few parameters for intervention.
- Certain factors such as climatic conditions, nutritional factors, psychological factors and activities of daily living could not be controlled during the study.

FUTURE RECOMMENDATIONS:

- Further studies can be conducted using bigger sample size.
- This Study can be done on female athletes also.
- Different training programs can be used.
- Similar studies can be performed on other sports.
- Similar studies can be performed on elite athletes.
- Further studies can use other outcome parameters for intervention.
- Similar studies can be done at various duration of training.

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APPENDIX-I

PILATES TRAINING EXERCISES FOR I & II WEEK-

NO	EXERCISE	PROCEDURE	REPETITION
1	PELVIC CURL	Subject crook lying with hands in side, and asked to do bridging with pelvic rotation	05
2	CHEST LIFT	subject crook lying with hands back of occiput and asked to lift their thorax from the floor	10
3	LEG LIFT SUPINE	Subject crook lying and asked to flex the hip with hands placed in both sides.	10
4	LEG LIFT SIDE	Subject in side lying, asked to lift the above leg up(abduction).	10
5	LEG PULL SIDE	Subject in side lying with one leg up and other leg taken up touching the up leg which is supported.	10
6	SPINE TWIST SUPINE	Subject in long sitting with erect spine, asked to abduct arm for 90`and then asked to twist both sides	10
7	CHEST LIFT WITH ROTATION	subject crook lying with hands back of occiput and asked to lift their thorax from the floor, accompanied with twisting both sides	5 each side
8	BACK EXTENSION PRONE	Subject prone lying hands on side with neck extension, asked to extend the thorax and lift body up	5 each side

EXERCISES FOR III & IV WEEK

NO	EXERSISE	PROCEDURE	REPITATION
1	ONE-LEG CIRCLE	Subject in supine lying hands in side asked to flex one leg and asked to rotate from hip	5 circle each leg
2	ROLL- UP	Subject supine lying with arms parallel to ears kept above and asked to roll up and touch the feet	5
3	SIT-UPS	Subject asked to do abdominal sit ups with hands back of neck	10
4	HUNDRED	Patient supine and asked to lift both shoulder and both legs up maintain boat position for 10 secs	10
5	SINGLE-LEG STRETCH	Patient supine flex hip and knee of one leg and asked to bring knee towards the chest	5 each leg
6	SINGLE STRAIGHT LEG STRETCH	Patient supine flex hip and extend the knee and asked to pull knee towards the chest	5 each leg
7	DOUBLE- LEG STRETCH	Patient supine flex hip and knee of both legs and asked to bring both knee towards the chest	10

8	CRISSCROSS	Supine lying with both hands supporting occiput and flex the leg and touch both side leg with elbows alternatively	5 each leg
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VTH WEEK PILATES EXERCISE TRAINING

NO	EXERCISE	TARGET MUSCLE	REPETITION
1	SPINE STRETCH FORWARD	Subject long sitting with erect spine asked to reach forward for the feet's and hold for 10 secs	5
2	ROLLING LIKE A BALL	Subject supine Both hands and leg flexed and joined and roll like a ball	10
3	SEAL PUPPY	sitting with both legs like butterfly adductor stretch holding feet's and asked to roll back	10
4	CRAB	subject supine both legs flexed and hands around leg and then roll back	6

5	ROCKER WITH OPEN LEG	Patient supine and asked to lift both shoulder and both legs up maintain boat position and then rock front and back.	6
6	ROLLOVER WITH LEG SPREAD	subject supine hands at side and asked to roll over with straight leg	6
7	BOOMERANG	subject supine hands at side and asked to roll over with straight legs and then rock back and forth	6
8	JACKKNIFE	subject supine hands kept at side and asked to lift body perpendicular to the floor and balance with only shoulders and push-up	5

VITH WEEKS PILATES EXERCISE TRAINING

NO	EXERCISE	TARGET MUSCLE	REPITITION -EACH LEG
1	SHOULDER BRIDGE	Subject crook lying with hands in side, and asked to do bridging with pelvic rotation support Is only with shoulders	5
2	SCISSORS	subject supine hip support with hands and move hip legs alternatively to flex and extend	5
3	LEG PULL	subject supine with hand supported at shoulder level and do bridge and lift one leg up	5
4	LEG PULL FRONT	subject supine with hand supported at shoulder level and do bridge and lift one leg up and move front and back	5
5	PUSH UP	subject prone with erect spine asked to do push-ups	5

APPENDIX-II

CALLISTHENICS TRAINING FOR 6 WEEKS

I & II WEEKS CALLISTHENICS EXERCISE TRAINING

NO	EXERCISE	VARIATION OF EXERCISE	REPITITION
1	FREE HAND EXERCISES	5	2

Free hand exercises consists of all basic flexion, extension, abduction, adduction and rotation movements are done.

III & IV WEEKS CALLISTHENICS EXERCISE TRAINING

NO	EXERCISE	EQUIOMENT	VARIATION	REPITITION
1	FREE HAND SERIES OF EXERCISE	NO EQUIPMENT	2	2
2	LIGHT DUMB-BELL SERIES	DUMB-BELL	5	2

Light dumb-bell exercises are simple all free hand exercises with dumb-bells and other basic arm movements.

V & VI WEEKS CALLISTHENICS EXERCISE TRAINING

NO	EXERCISE	EQUIPMENT	REPITITION	VARIATION
1	FREE HAND EXERCISES	NO EQUIPMENT	2	2
2	LIGHT DUMB-BELL SERIES OF EXERCISES	DUMB-BELL	2	2
3	STICK SERIES OF EXERCISES	DUMB-BELL	2	4

Stick series of exercises are same basic movements which are done with free hand and dumb-bell exercises are done with using sticks.

APPENDIX-III

PLYOMETRIC TRAINING FOR 6 WEEKS

SIDE TO SIDE ANKLE HOPS - Subject is asked to do hops in side to side direction.

STANDING JUMP AND REACH - Subject standing with arms took straight up and asked to jump and reach with hands.

FRONT CONE HOPS - A Cone is placed before the subject and asked to hop over the cone.

LATERAL JUMP OVER BARRIER - A small hurdle or cone is placed in side of subject and asked to make a lateral jump over the barrier.

DOUBLE LEG HOPS - Small leg hops are are done alternatively in both legs.

LATERAL CONE HOPS - subject asked to hop over a cone which is placed laterally.

DIAGONAL CONE HOPS - cones are placed 1m away from each other diagonally one after other.

STANDING LONG WITH LATERAL SPRINT - here subject does a long standing with wide base laterally and then does a jump front and sprints laterally.

SINGLE LEG BOUNDING - subject runs two steps and makes a hard bound to the surface with foot and does two hops and again runs.

LATERAL JUMP SINGLE LEG - subject jumps laterally to one side lands with other leg and same in other side also.

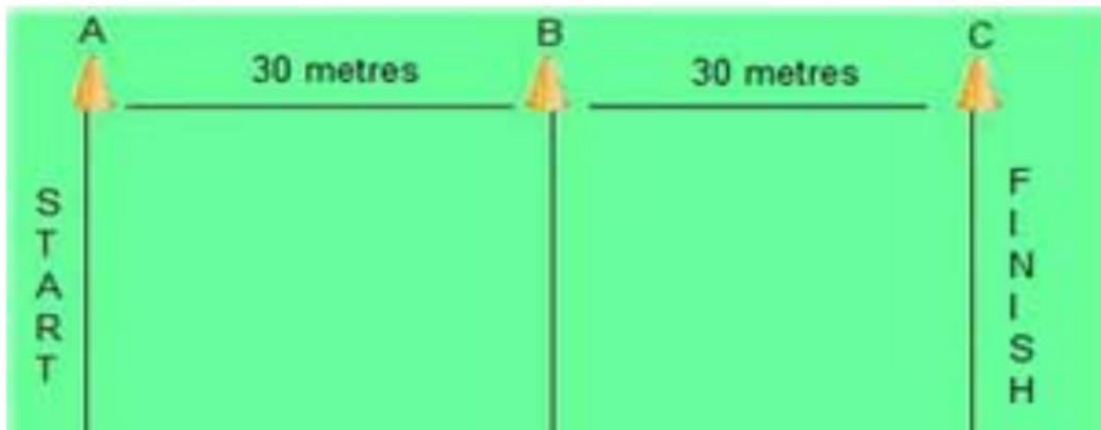
CONE HOPS WITH 180 DEGREE TURN - here two cones are placed apart and subject asked to hop over it with a 180 turn and to other cone thus making a circle.

HEXAGONAL DRILL - hops done in diagonal pattern cone hops with change in direction sprint - two cones are placed and subject asked to hop between the cones and run lateral in change in direction to and fro.

APPENDIX - IV
TEST PROCEDURES - ILLINOIS TEST



FLYING 30m SPRINT



SIT AND REACH TEST



VERTICAL JUMP TEST



APPENDIX – V

CONSENT FORM

This is to certify that I _____ freely and voluntarily agree to participate in the study “ **EFFECTS OF PILATES, CALLISTHENICS AND PLYOMETRIC TRAINING ON PHYSICAL PERFORMANCE OF VOLLEYBALL PLAYERS**”.

I have been explained about the procedures and the risks that would occur during the study.

Signature of the Participant:

Signature of the Witness:

Date:

I have explained and defined the procedure to which the subject has consented to participate.

Signature of the Researcher:

Date: